

Space Weather Technical Forecast

Issued on Wednesday, 12 April 2023 at 01:23 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales <https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales>

Space Weather Forecast Headline: Chance of M-class flares (R1-R2 Minor-Moderate radio blackouts) throughout.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity has been Moderate with an M1.37 flare peaking at 11/1016 UTC from AR3272. There are currently six sunspot regions on the visible disc. AR3276 gave an M-class flare on 10 April and continues to rotate into view on the southeast limb, and appears to consist of three small spots although further details may become apparent as it moves further onto the disc. AR3272 is the largest region on the disc, situated in the southeast quadrant. This consists of a large number of individual small spots. AR3273 near north centre disc has changed little in recent hours and currently remains relatively simple with little activity apparent. The other remaining regions on the visible disc appear to be small and simple. There have been no Earth-directed CMEs observed in available imagery over the past 24 hours

Solar Wind / Geomagnetic Activity: The solar wind as observed by DSCOVR at L1, was initially enhanced by a weak High Speed Stream (HSS), likely from CH91/+ over the last 24 hours. Solar speeds at 470 km/s have now declined to slow-ambient levels around 380 km/s. Density has been at near to slightly above average levels. The total IMF, Bt, has been weak to moderate, peaking early in the period near 9 nT. The north-south component, Bz, has been varying weakly between +7/-6 nT, but has been mostly northward directed. The phi angle remained in a resolutely positive orientation (away from the Sun). Geomagnetic activity was Quiet to Unsettled (Kp 1-3).

Energetic Particles / Solar Radiation: High energy proton flux (greater than 10MeV) as measured at GOES16, was at background levels. The high energy electron flux (greater than 2MeV) as measured at GOES16 was at background levels. The associated 24 hour fluence was below the Active threshold with an initially level trend, before rising in the second part of the period. The 12/0001 UTC observed fluence was 1.61e6 integrated pfu.

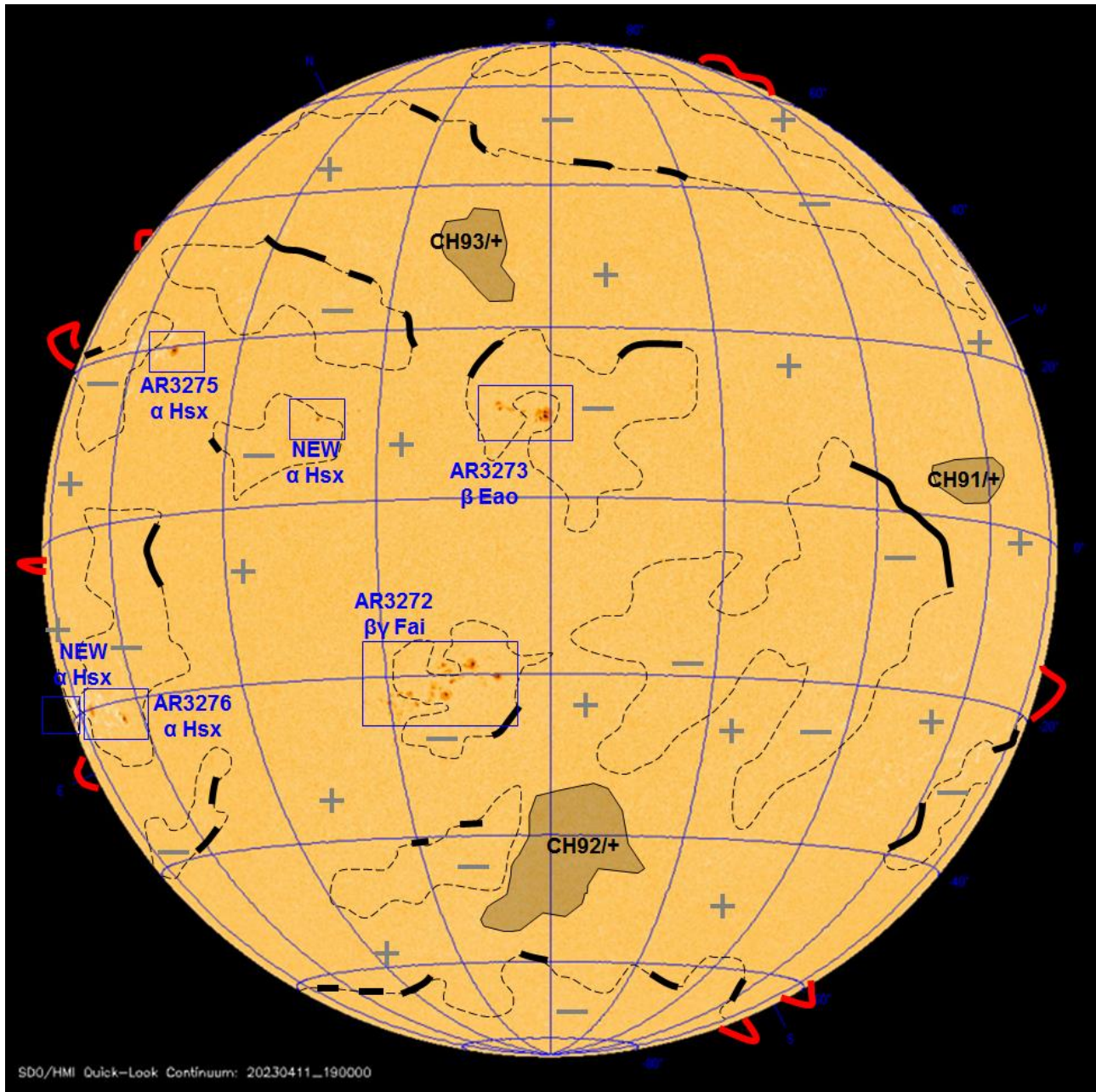
Four-Day Space Weather Forecast Summary

Solar Activity: Solar activity is expected to be Low to Moderate, with a chance of further isolated M-flares. AR3272 and AR3276 are the most likely sources of any activity.

Solar Wind / Geomagnetic Activity: There are no Earth-directed CMEs, although there is a low possibility of a glancing arrival from a CME which left the Sun on the 7 Apr, early on Day 1 (12 Apr), as well as another possible glance on Day 2 or 3 (13 or 14 April) from a filament eruption that left the sun on 9 April. Solar winds may reach slightly elevated levels, with further coronal hole sourced enhancements possible, however any geomagnetic activity is likely to remain limited. Quiet activity is forecast with a chance of Unsettled intervals and a slight chance of Active if any CME arrival occurs.

Energetic Particles / Solar Radiation: High energy (greater than 10MeV) proton flux is expected to persist at background levels. High energy (greater than 2 MeV) electron flux is expected to be at mostly background levels, perhaps peaking at high levels from day 2 (13 April) onwards. The associated 24 hour fluence is expected to remain below the Active threshold ($1e8$ integrated pfu), perhaps on a probable rising trend.

Figure 1. Solar Analysis Valid 2000UTC, 11 April 2023.



Key: Filament ____, Prominence ____, Magnetic Field Line - - -, Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α - β - $\beta\gamma$ - $\beta\gamma\delta$ and Zurich-McIntosh Axx etc.

Geomagnetic Storms:

There are no Earth-directed CMEs. However, there is a chance of a glancing interaction early Day 1 (12 Apr) due to a CME from 7 Apr. This is most likely to miss, passing south and ahead of Earth's position. A second glancing CME may occur either on Day 2 or 3 (13 or 14 April) from a filament eruption that left the sun on 9 April.

Earth appears to be exiting from a weak HSS, probably associated with CH91/+. The longevity of these winds is low confidence as the fast wind enhancement is missing from Enlil, while the 27-day persistence is contaminated by the arrival of a CME on the last rotation. Furthermore, a latitudinally narrow, but longitudinally broad coronal hole is situated across the northern disc, albeit somewhat obscured by the looping on the disc. In Enlil its associated fast wind can be seen passing above the Earth, only fading away on Day 3 (14 Apr). A further southern coronal hole (CH92/+) may also give an enhancement on Day 3 (15 Apr).

These features give a potential for Earth to see slightly elevated solar winds throughout the period however due to their positive polarity and the time of year, any geomagnetic enhancement is expected to remain subdued (Russell-McPherron effect). The forecast concerning geomagnetic activity is for Quiet conditions expected throughout, with isolated Unsettled spells and only a slight chance of Active intervals, if any slight CME glances occur.

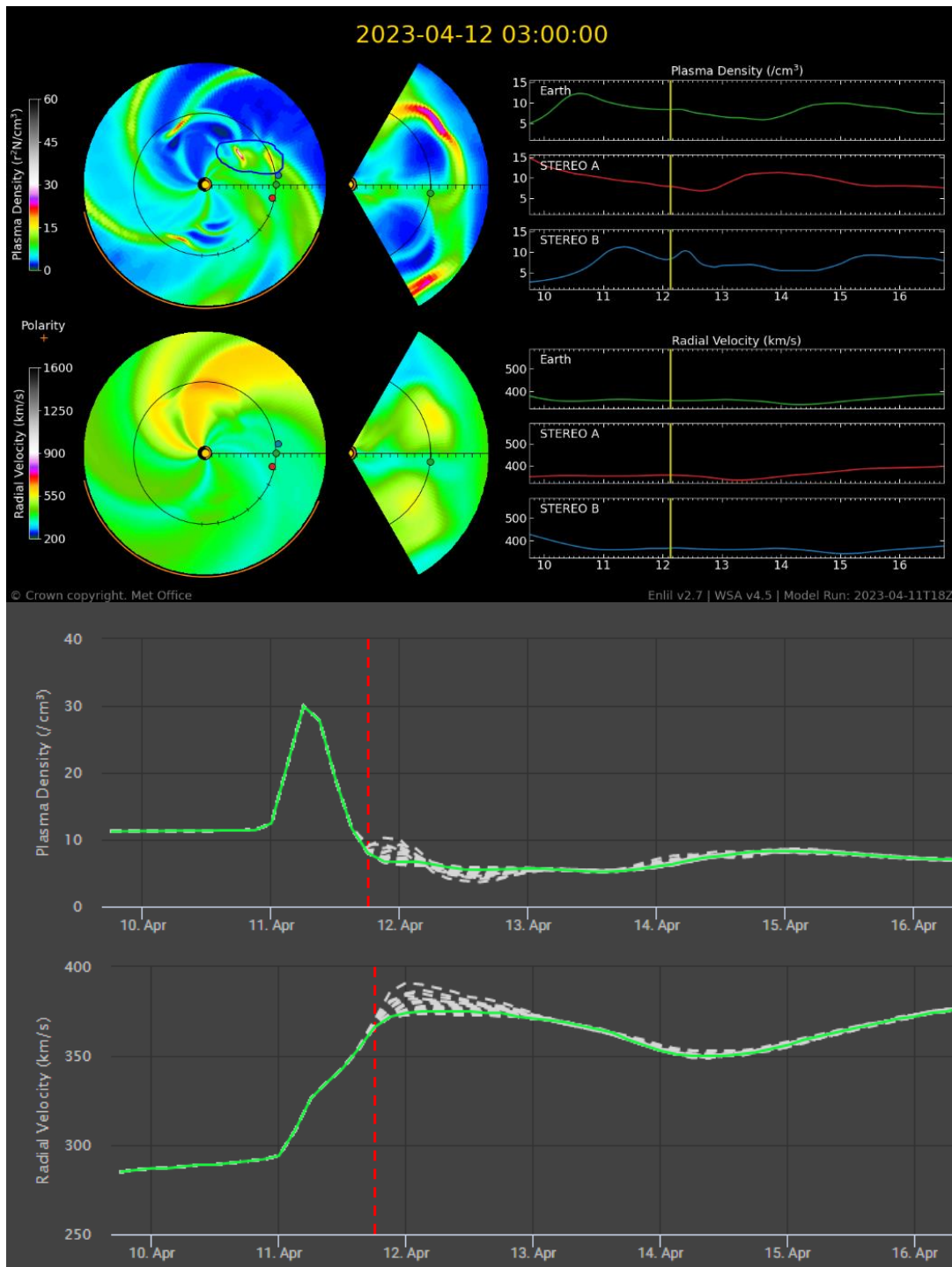
Geo-Magnetic Storm	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Minor or Moderate	G1 to G2	No	5	5	5	1
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections

Date/time 21.5R (UTC)	Halo: Full or Partial	Source	Source Location	Estimated Speed	Estimated Arrival Time	Comments
08/0107	Partial Halo	Filament Eruption	SW Limb	388 km/s	12/0300UTC	Most likely to miss but low chance of a glancing blow
10/0220	Partial Halo	Filament eruption	SW Limb	540 km/s	14/0000UTC	Most likely to miss but low chance of a glancing blow



Figure 2: Met Office ENLIL output showing both CMEs (highlighted in blue circle) probably missing earth along with Ensembles output.



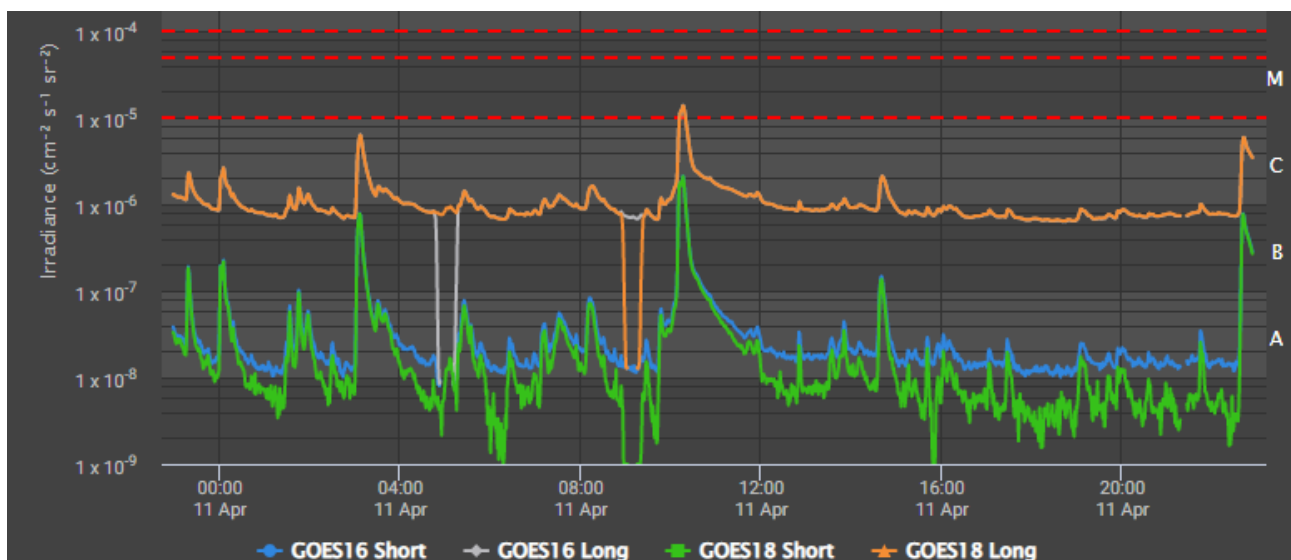
Radio Blackouts - X-Ray Flares:

Low to Moderate activity is expected to continue with the ongoing chance of isolated M-flares. There are two sunspots which have a history of M-flaring, along with several low level C-flares. AR3272 is a moderately sized region in the southeast quadrant, and is comprised of multiple small spots, with some limited magnetic complexity due to a couple of small reverse polarity spots near the main negative leaders. AR3276, however, remains more difficult to analyse, as it is still close to the southeast limb, with evidence of either a closely following active region or further spots related to AR3276. On the far-side this region appeared to be a source of a number of CMEs, and has a bright appearance in SDO aia-094 imagery. More complexity is likely to become apparent as it moves into a less oblique viewing angle.

Further regions presently on the disc include the second largest active region (3273) which has changed little in recent hours and displays a simple bipolar magnetic structure. Along with a few further smaller spots, there is a current trend for slowly increasing activity and further sunspot development appears likely, as well as new regions rotating onto the visible side.

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	Yes	40	40	40	40
Very Active	R3 to R5 X Class	No	2	2	2	2

Figure 3: X-ray flux at GEO as measured by GOES with 1 M-class flare and several flares at C-class.

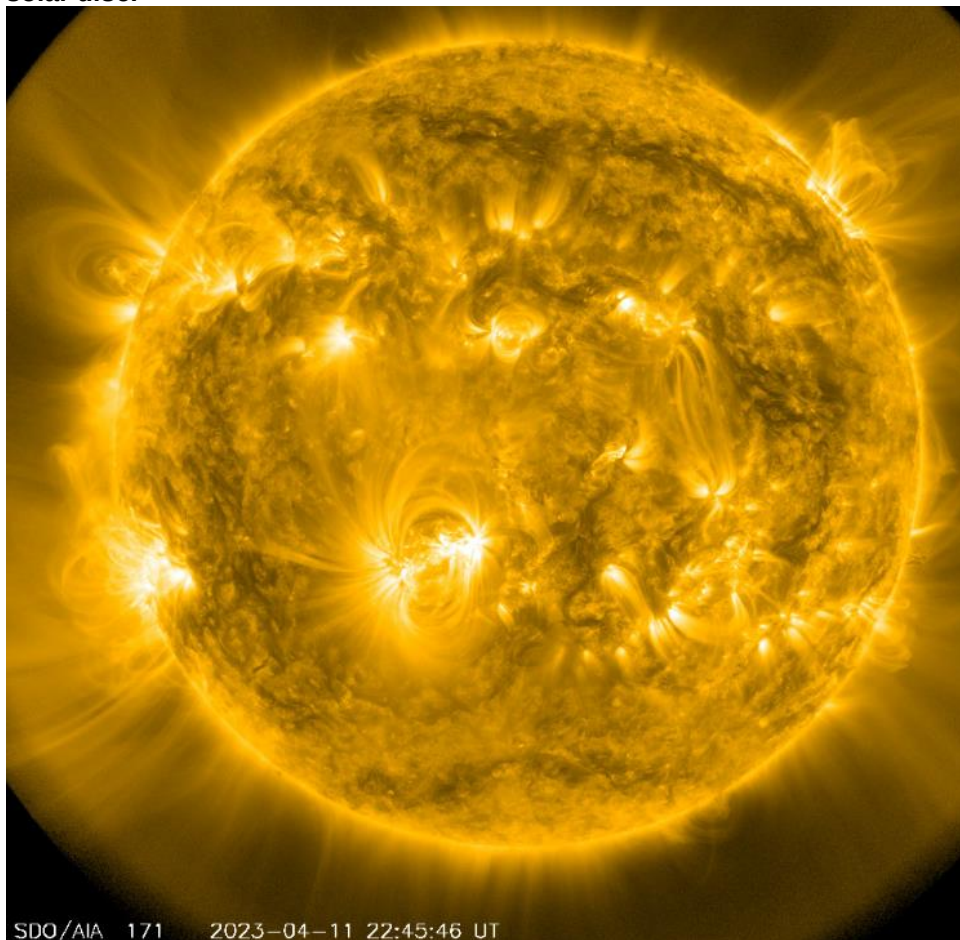


Solar Radiation Storms - (High Energy Protons):

High energy proton flux (greater than 10MeV), as observed by GOES-16, is likely to remain at background levels through the period. The majority of the sunspots on the disc are in the eastern hemisphere and currently unlikely to produce strong flares, however there is a very slightly increased risk late in the period as these, including AR3272 rotate across the western disc.

Radiation Storms	Level ($\text{cm}^{-2} \text{sr}^{-1} \text{s}^{-1}$)	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Active	$\geq \text{S1}$	No	2	2	2	5
Very Active	$\geq \text{S3}^*$	No	1	1	1	1
* S3 $\geq 10 \text{ MeV} \geq 1000 \text{ pfu}$ and / or $\geq 50 \text{ MeV} \geq 10 \text{ pfu}$. (pfu = $\text{cm}^{-2}\text{sr}^{-1}\text{s}^{-1}$)						

Figure 4: SDO AIA-171 imagery giving an indication of location of active regions on visible side of solar disc.



High Energy Electrons Event ($\geq 2\text{MeV}$):

The high energy (greater than 2 MeV) electron flux is at background levels and any rise due to the observed solar wind enhancements is expected to be subdued. Peak diurnal values might reach high levels from day 2 (13 April) onwards, but any rise is expected to be fairly modest. The associated 24 hour fluence is expected to be below the Active ($1\text{e}8$ integrated pfu) threshold throughout, but perhaps with a slight rising trend. REFM is suggesting only minor rises and is presently considered to be giving good guidance.

GEO Electron Environment	Level ($\text{cm}^{-2} \text{sr}^{-1} \text{day}^{-1}$)	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Active	$\geq 2 \text{ MeV}$ $\geq 1 \times 10^8$	No	1	10	20	30
Very Active	$\geq 2 \text{ MeV}$ $\geq 1 \times 10^9$	No	1	1	1	1

Figure 5: High energy electron flux at GEO and Met Office REFM output during April 2023, showing recent decline in activity.

